The role of a specific brain region in deciding between conflicting options

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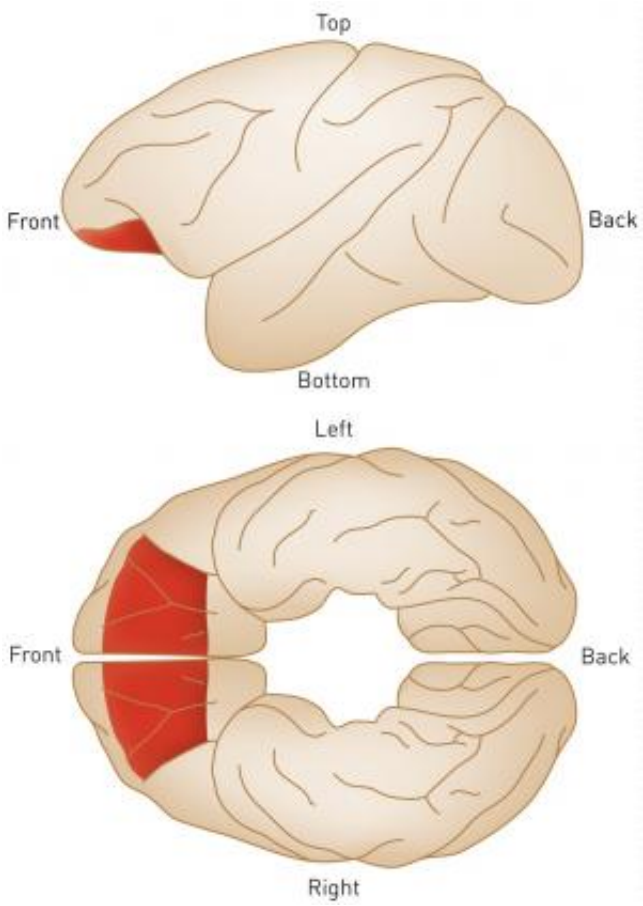

Figure 1: The prefrontal cortex (red) sits just behind the forehead in both humans and macaque monkeys (shown), and is the region in which executive control processing occurs. Credit: Keiji Tanaka, RIKEN Brain Science Institute

A type of information processing in the brain known as 'executive control' helps us make decisions when presented with conflicting options. Brain imaging studies of humans have established that specific regions in an area of the brain just behind the forehead, called the prefrontal cortex, contribute to executive control when choosing between conflicting options.

Keiji Tanaka and Farshad Mansouri from the Cognitive Brain Mapping Laboratory at the RIKEN Brain Science Institute and Mark Buckley from Oxford University in the United Kingdom have now revealed a previously unidentified role in executive control for a closely linked region of the brain called the orbitofrontal cortex.

"We previously found that the mid-dorsolateral prefrontal cortex plays an essential role in conflict-induced adjustment of executive control," explains Tanaka. "This region also has strong anatomical connections to the orbitofrontal cortex, posterior cingulate cortex and superior dorsolateral prefrontal cortex, and so we set out to examine the functional roles of these three areas in executive control."

The research involved assessing the performance of monkeys in a test of executive control before and after impairing the activity of each of these specific brain regions. The test was a version of the Wisconsin card-sorting test, in which monkeys had to match colored shapes according to either their color or shape. The matching rule was occasionally changed, and the monkeys discovered the current rule by trial and error. In low-conflict situations, the same choice satisfied both rules, but in high-conflict situations, the two matching rules resulted in two possible correct answers.

Unimpaired monkeys responded quicker in trials after experiencing the high-conflict situation in the previous trial. However, impaired brain function changed this behavior. "Impairment of the orbitofrontal cortex eliminated the difference in response time in trials following high- and low-conflict trials," says Tanaka. "This indicates that the orbitofrontal cortex is necessary for intact conflict-induced adjustment of executive control."

The researchers also recorded activity in orbitofrontal cortex neurons during the card-sorting test. Cells in the orbitofrontal cortex responded differently to high- and low-conflict situations, but

not to other variables such as different shapes or colors. This observation shows that cells of the orbitofrontal cortex respond to the level of conflict being experienced.

"The results reveal a functional role of the orbitofrontal cortex in executive control," says Tanaka, "by monitoring and representing the current state of the monkey and sending the signal to other parts of the prefrontal cortex to adjust executive control appropriately."

More information: Mansouri, F. A., Buckley, M. J. & Tanaka, K. The essential role of primate orbitofrontal cortex in conflict-induced executive control adjustment. The Journal of Neuroscience 34, 11016–11031 (2014). DOI: 10.1523/JNEUROSCI.1637-14.2014

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